Small Business Innovation Research/Small Business Tech Transfer

Dust-Free Fabrication of Uranium and Plutonium Oxide Powders for Radioisotope Systems, Nuclear Thermal Rockets, Nuclear Electric Propulsion, and Surface Power Reactors, Phase I

Completed Technology Project (2018 - 2019)

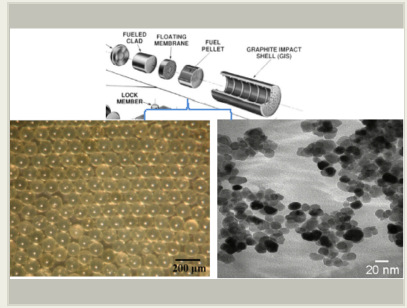
Project Introduction

This SBIR project will develop a manufacturing method for nuclear fuels that can be universally applied for space-power systems that utilizes a dust-free uranium oxide production unit. For the particular application to nuclear thermal propulsion, in which one wishes, (1) to maximize hydrogen propellant heating, and (2) to reduce fission product gas release and reactor particulates into the engines exhaust stream, if an ensemble of fine particles can be controllable fabricated in solution and bonded into a solid during solution drying, then the radiation-hazard can also be avoided. Furthermore, having fine control over the particulate geometry can allow one to tailor the fuel geometry such that the hydrogen heating is maximized and the fission-product gas release is minimized. The fabrication technology will achieve high through-put granule formation without the formation of hazardous particulates in an aqueous solution via either internal gelation sol-gel methods or colloidal assembly. Previous work with cerium, a surrogate for uranium and plutonium, has demonstrated the production of monodisperse microspheres (~ 3 % diameter uncertainty) of cerium dioxide, showing that the desired sizes can be produced, purity requirements can be met, and that pressurized water treatments modify microsphere properties such that they do not produce fines or strongly agglomerate during heat treatments. Nanostructured metal-oxides provide pathway through which higher purities and greater densification can be achieved. During Phase I, we will optimize the starting material recipe for the high-throughput growth of stable, conductive fuel-pellets, using cerium oxide as a uranium surrogate, so that the uranium oxide fuel manufacturing process can be optimized during Phase II.

Anticipated Benefits

For propulsion applications, nuclear thermal rockets (NTRs) have been investigated due to their high specific impulse that allows for more efficient use of propellant and allows for lower system masses than those using chemical propellants. NTRs could also reduce transit times for manned missions, reducing astronauts' exposure to radiation and zero gravity. The flexibility of the fuel-form proposed allows for its use in both space power (Mars mission fission reactor) and NTR applications. .

Cerium oxide in microscale form is important in industrial applications such as in solid oxide fuel cells, insulators, polishing materials, gas sensors, and as catalysts. CeO_2 nanoparticles employed in biological systems are of interest because they have been shown to be non-cytotoxic and react catalytically with reactive oxygen species. They can be considered as a new class of therapeutics due to the fact that the material itself has the therapeutic effects once internalized by cells.



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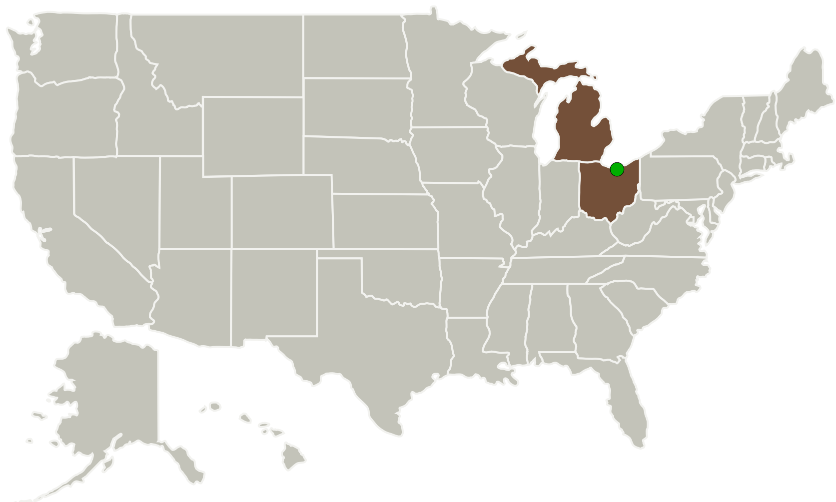
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Amphionic, LLC	Lead Organization	Industry Small Disadvantaged Business (SDB)	Dexter, Michigan
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations	
Michigan	Ohio

Project Transitions

July 2018: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Amphionic, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

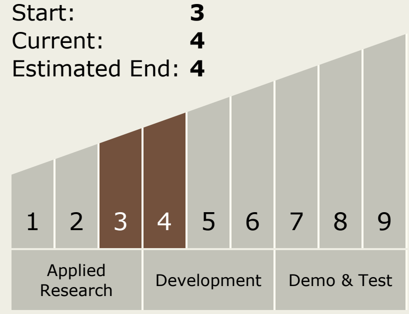
Carlos Torrez

Principal Investigator:

Manhee Jeong

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**

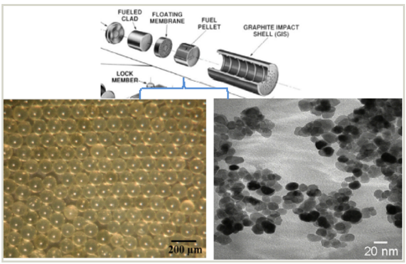


February 2019: Closed out

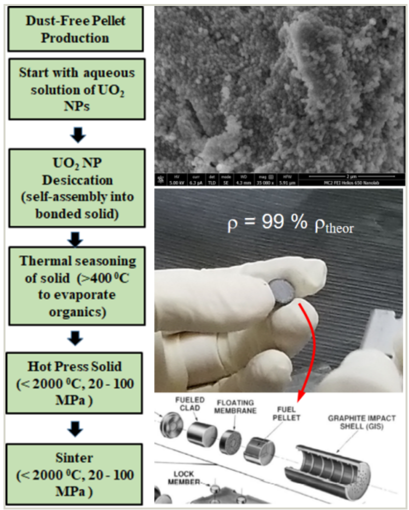
Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141022)*

Images



Briefing Chart Image
Dust-Free Fabrication of Uranium and Plutonium Oxide Powders for Radioisotope Systems, Nuclear Thermal Rockets, Nuclear Electric Propulsion, and Surface Power Reactors, Phase I
(https://techport.nasa.gov/image/134433)



Final Summary Chart Image
Dust-Free Fabrication of Uranium and Plutonium Oxide Powders for Radioisotope Systems, Nuclear Thermal Rockets, Nuclear Electric Propulsion, and Surface Power Reactors, Phase I
(https://techport.nasa.gov/image/130726)

Technology Areas

Primary:

- TX01 Propulsion Systems
  └ TX01.4 Advanced Propulsion
    └ TX01.4.3 Nuclear Thermal Propulsion

Target Destinations

The Moon, Mars, Others Inside the Solar System